Operating Experience Weekly Summary 99-22

May 28 - June 3, 1999

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EVENTS

1. VIEWING PORT ON PRESSURE VESSEL BURSTS DURING PRESSURIZATION

On May 20, 1999, at the Argonne National Laboratory—East, a researcher and a technician were pressurizing a stainless steel pressure vessel to 900 psi with nitrogen when one of three glass viewing ports failed catastrophically between 700 and 800 psi. Projectiles of glass chipped a masonry-blocked wall, shattered overhead fluorescent lamps, and severely damaged an overhead ventilation duct. The technician sustained minor cuts and abrasions on his arm, face, and head. His injuries could have been more serious if he had been directly struck by a window fragment. Both individuals immediately left the room. They returned and shut off the nitrogen gas after it was apparent that the situation was stable. Investigators learned that the researcher and technician had just reinstalled the window after placing a mirror in the vessel and that they both were aware of a readily visible flaw in the glass at the time of reinstallation. (ORPS Report CH-AA-ANLE-ANLEES-1999-0001)

The pressure vessel, which is a 2-ft long, 1-ft diameter cylinder, has a maximum allowable pressure of 1,100 psi with an operating pressure of 950 psi. The viewing ports are 1.25-in. thick quartz windows that are held in place by metal fittings secured with bolts. An O-ring held in place by Teflon® gaskets seals the viewing port. The pressure vessel is used to examine the characteristics of diesel fuel aerosols. There were no fuel aerosols in the vessel while the technician was increasing the nitrogen pressure. Investigators photographed the scene and left all significant items in place pending further analysis. The division director suspended all normal work in the laboratory. An investigation continues into roles and responsibilities, technical skill/training/knowledge, operating procedure, and design. OEAF engineers will follow this event and will provide additional information as it becomes available.

KEYWORDS: damage, injury, nitrogen, pressure vessel, pressurized, projectile

FUNCTIONAL AREAS: Research and Development

2. OPERATOR VIOLATES POSTED RADIOGRAPHY BOUNDARY

On May 21, 1999, at the Idaho National Engineering and Environmental Laboratory, an operator crossed a radiography boundary to obtain routine round-sheet readings on equipment in the Advanced Test Reactor Warm Waste Treatment Facility while radiography operations were in progress. The radiography boundary was posted as “Danger – Radiography In Progress; Radiation Area Keep Out: Consult Radiographer For Entry.” The operator observed radiography personnel in the area and reasoned that since they were in the area and he would not have to cross a posted high-radiation boundary, it would be safe to enter the area to request permission from them to take his readings. Although the operator did not receive any dose, radiography sources can create radiation fields in which permissible occupational dose standards can be exceeded in a short time. (ORPS Report ID--LITC-ATR-1999-0013)

Radiography procedures require a qualified individual to monitor the high-radiation boundary, which was at the entrance to a high-density concrete shielded cubicle, where radiography was being performed. Investigators determined that the operator was inside the posted radiography area (but not within the high-radiation area) while the 37-Ci cobalt-60 source was out of its shielded container. They also determined that a radiation control technician responsible for monitoring the high-radiation boundary had been performing radiation surveys within the posted radiography area when the operator crossed the boundary. A quality technical lead person, who was performing senior supervisory watch duties and keeping track of how long the source was out of its shielded container, told the operator to leave the area by the same path he used to enter it and to ask the radiation control technician for permission to take his readings within the posted radiographic boundary. The operator did not comprehend that he was to leave the area and obtain permission from the radiation control technician before re-entering. Instead, he took his readings and then hailed the radiation control technician to ask permission to leave by a different path. The radiation control technician did not realize that the operator had been in the area and directed him to leave immediately. Quality, radiological controls, and operations managers ordered a dose evaluation based on the operator’s thermoluminescent dosimeter. The dose evaluation indicated that the operator had received no exposure. Investigators determined that radiation streaming through high-density concrete walls at piping penetrations was a possible source of exposure, but the operator was not in close proximity to these penetrations.

The quality technical lead person informed the shift supervisor, who immediately visited the area to investigate. Without removing the posted radiography boundary rope and postings, the radiation control technician, who knew that the radiography source was locked in its retracted, shielded position, authorized the shift supervisor to enter the radiography area, which was also in violation of personnel access requirements. The shift supervisor orally reprimanded the operator and counseled him on the need to rigorously adhere to radiological postings. The Test Reactor Area manager directed that no further radiography be allowed without his permission.

NFS has reported similar events involving inadequate radiological controls in several Weekly Summaries. Following are some examples.

- In Weekly Summary 99-17, OEAF engineers reviewed Nuclear Regulatory Commission (NRC) Information Notice 99-04, *Unplanned Radiation Exposures to Radiographers, Resulting from Failures to Follow Proper Radiation Safety Procedures*. The NRC issued the information notice on March 1, 1999, as a reminder of the risk of unplanned high radiation exposures from radiography equipment and the need for proper radiation safety practices to prevent such exposures. The notice was prompted by a series of incidents that have resulted in unplanned exposures involving the failure to follow proper radiation safety procedures. (NRC Information Notice 99-04)

- Weekly Summary 98-25 reported two events where personnel did not adhere to established radiography control requirements. In the first event, a facility operator at the Savannah River Site entered a barricaded area where radiography was being performed because he incorrectly assumed that he was allowed to pass through the barricaded area without an escort. In the second event, researchers at the Los Alamos National Laboratory Pajarito Laboratory failed to make proper notifications, post an exclusion area, or activate warning lights before conducting a radiography experiment, resulting in two security officers receiving a potential unattenuated dose of approximately 1 mrem. Investigators determined that the researchers had failed to follow the procedure for the experiment. (ORPS Report SR--WSRC-TRIT-1998-0007 and ALO-LA-LANL-TA18-1998-0006)

- Weekly Summary 95-06 reported two events involving improper personnel entries into radiography areas. At the Los Alamos National Laboratory, an employee misinterpreted a posting and entered a radiography exclusion area in violation of posting requirements. The employee could have received a dose of approximately 200 mrem if the radiography equipment had been operating while he was in the area. At the Savannah River In-Tank Precipitation Facility, a tank operator entered a radiography area to operate equipment. Facility personnel determined that personnel access controls were inadequate because they allowed access to the radiography area through an unbarricaded entrance point. (ORPS Reports ALO-LA-LANL-TRITFACILS-1995-0002 and SR--WSRC-ITP-1995-0003)

Events involving loss of administrative control during radiography are significant because radiography sources can create extremely high radiation fields in which allowable dose limits can be exceeded in a short time. These events underscore the importance of good communication and verification that radiography exclusion areas are completely barricaded, clearly marked, and cleared of personnel.

Facility managers should ensure that employees understand their responsibility for complying with procedures and observing the postings and barricades established for radiography. Facility managers and radiation protection managers should ensure that radiological procedures are complete and accurate. They should also ensure that facility personnel are fully briefed about radiography activities that may be performed at a site or facility and about the steps employees should take to avoid unplanned exposure.

Facility and radiation protection managers at facilities where radiography may occur or other radiation-generating devices may be operated should review their facility program compliance with the following articles in DOE/EH-0256T, *DOE Radiological Control Manual,* Part 1.

- Article 365, “Radiation-Generating Devices,” specifies the requirements for the operation and control of radiation-generating devices. It requires stringent physical and administrative control of radiography sources to prevent overexposure to operating and support personnel and to personnel in adjacent work areas. Article 365 incorporates related requirements by reference to the following documents: (1) DOE O 5480.4*, Environmental Protection, Safety, and Health Protection Standards*; (2) ANSI N43.3, *American National Standard for General Radiation Safety – Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV*; (3) ANSI N43.2, *Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment*; and (4) 10 CFR 34, *Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations*.

- Article 655, “Radiographers and Radiation-Generating Device Operators,” contains training and qualification requirements for radiographers and radiation-generating device operators. It states that radiographers should be trained in accordance with 10 CFR 34.31 and that radiation-generating device operators should have training appropriate for the radiation source involved and commensurate with the level described in 10 CFR 34.31. Article 655 incorporates related requirements by reference to DOE O 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, which mandates the use of ANSI N43.3, *American National Standard for General Radiation Safety – Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV*, for operations involving the irradiation of materials.

KEYWORDS: exposure, radiation protection, radiographer, radiography

FUNCTIONAL AREAS: Radiation Protection

3. MULTIPLE LOCKOUT/TAGOUT VIOLATIONS AT FERNALD

On May 27, 1999, at the Fernald Environmental Management Project, subcontractor pipe fitters violated lockout/tagout procedures when they attempted to cut the cap off the end of a pressurized, 2-in. polyvinyl chloride domestic water line. As they penetrated the line, water began to spray out and they notified a utility engineer, who closed the line's isolation valve and stopped the leak. The pipe fitters thought the line was already isolated and depressurized based on the configuration of the system the previous day. However, because the pipe fitters did not install their own personal locks or tags, the operations supervisor was able to un-isolate the line and return the system to service for the performance of a pressure test. The failure of the pipe fitters to follow facility lockout/tagout procedure requirements for establishing positive energy control on the line created a hazard that could have caused personnel injury or equipment damage. (ORPS Report OH-FN-FDF-FEMP-1999-0012)

The pipe fitters cut the cap off the end of the line to install a coupling, which would allow them to extend the line to equipment wash pads as part of the On-Site Disposal Facility (OSDF) project. Investigators determined that on the preceding day the isolation valve for the line had been locked and tagged by both the OSDF operations supervisor and a different subcontractor crew. The morning of the event, the other subcontractor crew notified the operations supervisor that they had removed their locks and tags and that the system was ready to be pressure-tested. The operations supervisor removed his lock and tag on the isolation valve and restored the system to service, which pressurized the line to approximately 50 psi. However, he was not aware of the work being performed by the pipe fitters installing the coupling downstream of the isolation valve, and the pipe fitters were not aware that the system had been restored and pressurized. Investigators also determined that the pipe fitters who cut the line (1) were not current in the facility's lockout/tagout program qualifications, (2) did not verify that the line was isolated before cutting it, and (3) did not install any personal locks or tags on the system for positive energy isolation.

Additionally, investigators determined that the same pipe fitters violated lockout/tagout procedures when they originally removed a valve from the line and installed the cap they cut off. They did not hang their own personal tags and also performed this work under the isolation tags of the other subcontractor crew. One of the pipe fitters told an OSDF construction engineer, who was not associated with the work to extend the line, that his lockout/tagout qualifications had expired and inquired if a lock and tag was required for removing the valve and installing the cap. The engineer responded that the isolation valve was locked and tagged shut, but he did not verify whose locks and tags were on the valve. The pipe fitters understood the engineer's response to mean that lockout/tagout requirements did not apply to their work and that they could proceed because of the existing lockout/tagout on the isolation valve. To verify that the system was depressurized and isolated, the pipe fitters opened the valve they were going to remove. There was no indication of pressure, but the pipe fitters did not hang their own tags to establish positive energy control on the line.

In response to this event, the prime contractor ordered a stand-down of all subcontractor work activities associated with the OSDF project. Project subcontractors gathered to discuss general safety topics, including lockout/tagout requirements, penetration permits, work planning, and work activity communications. Individual subcontractor work crews also met to discuss the safety aspects of their specific phases of the project. Additionally, the pipe fitters' prime subcontractor assumed responsibility for the lapse in their lockout/tagout qualifications and has implemented a tracking system that will be reviewed weekly. The system will notify subcontractors at least 60 days before the expiry of their qualification and will direct them to remain current in their training.

Multiple violations of personnel safety barriers and lockout/tagout procedures occurred during this event.

- The prime subcontractor failed to ensure that the pipe fitters' lockout/tagout qualifications remained current.

- The pipe fitters failed to provide positive energy isolation. They did not hang their personal lock and tag on the line's isolation valve when they removed the valve to install the pipe cap and again when they removed the pipe cap.

- The pipe fitters failed to properly verify the system's configuration before cutting off the pipe cap, and they failed to communicate their work activity to the facility owner.

- The operations supervisor failed to determine that the line was ready to be returned to service by verifying that no other work was being performed on the line.

- The construction engineer did not verify whose tags were on the isolation valve and did not require the pipe fitters to hang their own personal tags.

These events illustrate the potential hazards to personnel who knowingly or unknowingly work on pressurized systems or isolated systems that contain stored energy. It is important that workers verify that proper isolation boundaries have been established and that stored energy has been relieved before they start to work. Facility managers should ensure that all managers and supervisors understand their expectations for the lockout/tagout program and that they effectively communicate and enforce them. These expectations should include attention to detail, verbatim compliance, effective communications, and defense-in-depth. Following are some documents that facility managers should review to ensure that safe work practices associated with potentially pressurized systems are incorporated in their facility safety programs.

- DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, Section 4.2.3.3, states that systems, portions of systems, and components that operate at temperatures and pressures above ambient should be vented and, if necessary, drained or cooled. Section 4.5.1 states that only personnel who are qualified and authorized should be permitted to isolate equipment or install locks or tags. When the lockout/tagout is installed, it should be placed under the control of the person requiring the protection. This section also states that the adequacy of protection should be verified by the individual(s) who will be working under the lockout/tagout and that they should verify all isolation devices are properly positioned and tagged. Section 4.5.2 states that prior to removal of a lockout/tagout, the person responsible for system operation should inform all affected personnel that the lockout/tagout is being removed. Section 4.9 states that whenever outside contractors are engaged in work covered by the lockout/tagout program, the facility supervisor and the contractor should discuss the protection requirements for the job. The contractor should ensure that all subordinate personnel understand the lockout/tagout procedures. This guidance is also repeated in DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Chapter IX, "Lockouts and Tagouts."

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that control the hazards associated with a job. The guide also provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards.

Facility managers should also review DOE/EH-0540, Safety Notice 96-05, "Lockout/Tagout Programs." The notice recommends that workers be cognizant of lockout/tagout boundaries and that they verify that no hazardous energy exists within these boundaries. It also summarizes lockout/tagout events at DOE facilities, provides lessons learned and recommended practices, and identifies lockout/tagout program requirements.

DOE technical standards are available at http://www.doe.gov/html/techstds/techstds.html. Safety Notice 96-05 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html. A copy of the *Hazard and Barrier Analysis Guide* is also available from the ES&H Information Center or at http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf.

KEYWORDS: communication, equipment status, lockout and tagout, personnel safety, training and qualifications

FUNCTIONAL AREAS: Hazards and Barrier Analysis, Industrial Safety, Training and Qualification

4. SHORT-TERM EXPOSURE LIMIT EXCEEDED FOR METHYLENE CHLORIDE

On May 27, 1999, at the Paducah Gaseous Diffusion Plant, the health and safety officer for two subcontractor chemists determined definitively from personnel monitoring samples taken earlier in the month that the chemists had been exposed to a methylene chloride (MC) vapor concentration that exceeded the OSHA short-term exposure limit (STEL). The sample results indicated that the chemists had a 15-min exposure at a concentration of 260 ppm, which exceeds the OSHA 15-min STEL of 125 ppm. Additional samples indicated they had an 8-hr exposure of 12 ppm, which is less than the OSHA action level of 12.5 ppm and is also less than the OSHA 8-hr time-weighted average permissible exposure limit of 25 ppm. The chemists had been extracting soil samples with MC and acetone to determine their organic and metal content. Although the work plan required all work to be performed under a ventilated hood, the chemists had placed some treated samples outside the hood. While they did not experience any ill effects from the short-term exposure, the chemists' failure to follow process procedures increased their exposure to MC and could have caused adverse health effects. (ORPS Report ORO--BJC-PGDPENVRES-1999-0003)

The chemists, working in a mobile field semivolatile laboratory, were performing a baseline soil characterization study as part of a remedial investigation project that was testing the soil for organic and metal contamination. Drilling contractor personnel had collected the soil samples and delivered them to the chemists in the mobile laboratory. Preliminary breathing zone samples taken by the health and safety officer in early May had indicated elevated levels of MC, and on the strength of these provisional results, the chemists' managers ordered the laboratory to be shut down on May 12. Methylene chloride, also known as dichloromethane (CH_2Cl_2), is an organic solvent that looks like water and has a mild, sweet odor. It is widely used as an industrial solvent and as a component of certain aerosol products. Acute exposure to MC has been associated with impairment of the central nervous system, liver and kidney damage, respiratory tract irritation, sluggishness, intoxication, lightheadedness, nausea, headache, unconsciousness, and even death. The National Institute for Occupational Safety and Health considers MC to be a potential carcinogen.

Investigators determined that the chemists had treated the soil samples with MC and acetone and then placed them inside a ventilated hood for contaminant extraction and analysis. Project procedures required all extractions to be performed under a hood. However, the chemists received and treated more soil samples than the hood workspace could accommodate, and they began placing the samples outside the hood. Investigators also determined that the chemists were not wearing any respiratory personal protective equipment while the treated soil samples were stored outside the hood. As a corrective action, a new ventilated hood was installed that has a larger workspace to accommodate a greater number of samples. The health and safety officer allowed the laboratory to restart operations after he measured the new hood's face velocity and breathing zone and determined them to be adequate for the extraction work, and after he instructed the chemists to comply with extraction procedure requirements to perform all work under the hood.

NFS has reported other events where personnel have inhaled hazardous vapors, gases, and materials. Some examples follow.

- Weekly Summary 99-07 reported that three workers at the East Tennessee Technology Park were exposed to hexachlorobenzene, a confirmed carcinogen in animals, above the threshold limit value/time-weighted average limit of 0.002 mg/m^3 recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). In addition, one of the sample results exceeded the protection factor for the respirators worn by 50 percent. The workers were exposed in the course of repackaging solid waste material for incineration. Environmental, safety, and health personnel had reviewed the work but expected the exposure to be below the ACGIH limit. (ORPS Report OR--BJC-K25WASTMAN-1999-0004)

- Weekly Summary 99-01 reported that a scientist at the Hanford Site Pacific Northwest National Laboratory was exposed to airborne lead particulates that exceeded the OSHA permissible exposure levels as he was cutting epoxy-mounted lead- and lead-oxide-containing plates with a water-cooled tile saw. The scientist's 8-hr time-weighted average exposure was 138 $\mu g/m^3$, which exceeds the OSHA 8-hr permissible exposure level of 50 $\mu g/m^3$. Investigators determined that although the scientist had cut lead plates twice before with the water-cooled tile saw, no one performed lead monitoring at that time. Chronic lead exposure may result in severe damage to blood-forming, nervous, urinary, and reproductive organs. (ORPS Report RL--PNNL-PNNLBOPER-1998-0023)

- Weekly Summary 98-42 reported that two workers at the Idaho Waste Experimental Reduction Facility were exposed to airborne cadmium dust at levels that exceeded the protection factor for the respiratory protection equipment they were using. The individual workers could have been exposed to as much as 1.16 and 2.68 times the permissible exposure limits for cadmium dust, 5 $\mu g/m^3$. The workers were cleaning and inspecting an incinerator off-gas heat exchanger following a test burn for equipment qualification. Metallic cadmium was one of the materials injected before the cleaning and inspection activity. The facility manager directed facility personnel to revise the Lead and Cadmium Compliance Plan so it contained more effective engineering and administrative controls for mitigating cadmium hazards. (ORPS Report ID--LITC-WERF-1998-0007)

- Weekly Summary 98-27 reported that three reactor auxiliary operators at the Idaho National Engineering and Environmental Laboratory Advanced Test Reactor were exposed to trimethylamine above the short-term 15-min exposure limit while recharging anion exchange resin in a demineralizer tank. Investigators believe that the excessive off-gassing of trimethylamine was caused by drums of resin being stored at a higher temperature than that recommended on the material safety data sheet. The operators were exposed for less than 30 sec and did not exhibit any symptoms of respiratory problems. (ORPS Report ID--LITC-ATR-1998-0014)

This occurrence underscores the importance of complying with chemical safety rules and following the work plan. If the chemists had treated only as many soil samples as could be accommodated by the hood, it is unlikely that they would have been exposed to a concentration of MC greater than established occupational exposure levels. Managers of facilities where MC is stored and used should review their chemical safety programs to ensure that solvent usage and storage requirements are being met. Facility managers responsible for determining how and where chemicals are stored should consult the DOE Chemical Safety Home Page at http://tis.eh.doe.gov:80/web/chem_safety/.

OSHA regulation 29 CFR 1910.1052 establishes the requirements for employers to control occupational exposure to MC. It provides guidance that includes permissible exposure levels, exposure monitoring, regulating areas for MC usage, required respiratory protection, and protective work clothing and equipment to prevent MC-induced skin or eye irritation. OSHA regulations can be reviewed at http://www.osha-slc.gov/OshStd_toc/ OSHA_Std_toc.html.

National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, 1995, provides guidance and recommendations for the safe handling and storage of chemicals, primarily in laboratory settings. It contains information about avoiding inhalation of hazardous chemicals and guidelines for using and operating ventilated hoods. Information on ordering this book can be obtained from National Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C 20418. The book can also be ordered from most large bookstores.

KEYWORDS: chemical, exposure, inhalation, occupational safety, work planning

FUNCTIONAL AREAS: Industrial Safety, Procedures, Work Planning

5. ELECTRICAL NEAR MISS DURING VACUUM PUMP REPLACEMENT

On May 21, 1999, at Los Alamos National Laboratory, the facility manager designee for the Plutonium Processing and Handling Facility reported an electrical near miss associated with the replacement of a vacuum pump. Electricians had wired a new control panel for the replacement pump using an existing 480-V ac power source even though the control circuits were designed for 208 V ac. The design change package (DCP) for the work clearly said that no changes to the existing electrical power would be required, and no electrical drawings, which would have shown the 208-V ac requirement for the control circuits, were provided with the DCP. Electricians discovered the wiring problem before the control circuits were energized. The facility manager designee issued a formal stop-work order on the pump replacement activities. This event is significant because energizing the equipment from the wrong power source could have resulted in equipment damage or personnel injuries. (ORPS Report ALO-LA-LANL-TA55-1999-0030)

The scope of the DCP for the vacuum pump replacement required replacing an old oil-type vacuum pump with a new dry, blower-type vacuum pump. This was not a like-for-like exchange but the replacement of an old pump by an improved one that required piping modification. According to the DCP, there was to be no change in the electrical power supply for the replacement pump. Configuration management personnel, who had originally reviewed the design drawing and document checklist for the DCP, later said that no electrical drawings had been included with the package, despite the fact that the new control circuits for the vacuum pump were designed for 208 V ac.

On May 20, 1999, a Nuclear Material Information Management (NMT-3) employee discussed the vacuum pump replacement job with the electricians who were replacing the vacuum pump motor and control circuits. One of the electricians mentioned that they had not been given any electrical drawings for the work. The NMT-3 employee knew that drawings existed and he got them for the electrician to review. The electrician noticed that the power supply and the program logic controller in the control panel for the pump were rated for only 208 V ac. He told the NMT-3 employee that he had connected 480-V ac power into the control panel. The NMT-3 employee recommended that the electrician stop work on the vacuum pump. He also notified the individual who was directing the work activities about the problem, and they both told the electricians to stop work on the project. The next morning the NMT-3 employee informed the facility manager designee of the incident. The facility manager designee decided that the situation was a near-miss event because the 480-V ac power supply was already connected to the control panel even though it was still locked and tagged out of service.

Facility management conducted a critique of the event. Critique members learned that the group in charge of the replacement project had initiated a field change request (FCR) following the discovery of the missing electrical drawings and the connection of the control system to the wrong power source. However, because the electrical work was not covered by the original scope of the DCP, the facility manager designee determined that a new DCP specific to the electrical work should be submitted rather than an FCR to the original DCP.

Investigators determined that although the original DCP called for only minor piping modifications to accommodate the different dimensions of the new pump, several FCRs had been submitted in support of the work. One FCR was necessary to modify the pump foundation to support the new pump. The new control system was an afterthought that was also added to the DCP using an FCR. However, the new control system significantly changed the scope of work, and this change was not addressed by the original unreviewed safety question determination. Although facility personnel conducted technical reviews of the FCRs as required by facility procedures, the adequacy of the review for the control system installation is questionable. Investigators also determined that the electrical drawings had gotten separated from the DCP.

This event illustrates the importance of using complete and accurate DCPs that include all instructions and drawings to support the work activity. DCPs should also include any hazards analysis, safety recommendations, and work precautions. In this event the electricians should not have proceeded with the control system installation without proper drawings. Also, field-directed work should be minimized, and a major change to the original scope of work should be thoroughly reviewed and evaluated and, if necessary, should be performed under its own DCP rather than an FCR.

DOE-STD-1073-93, *Guide for Operational Configuration Management Program, Including the Adjunct Programs of Design Reconstitution and Material Condition and Aging Management, Parts 1 and 2,* addresses technical reviews of modifications as part of the change control element. Section 1.3.4.2 of the standard recommends that changes be reviewed and approved by the design authority before they are implemented. It states that these reviews should evaluate safety, environmental, and mission impacts and should determine post-implementation acceptance criteria. Section 1.3.4.3 recommends that managers review the proposed changes to verify that the change package is complete. Section 1.3.4.4 says that each change should be implemented in accordance with its approved change package. The change process should include a mechanism for field change requests, and technical reviews and approvals of field changes should be carried out with the same rigor as those in the original package.

KEYWORDS: electrical safety, modification, near miss, work package

FUNCTIONAL AREAS: Construction, Modifications, Work Planning

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. DEFICIENCIES IN SUBCONTRACTOR-SUPPLIED ELECTRICAL EQUIPMENT

OEAF engineers reviewed four final reports for electrical occurrences at the Savannah River Environmental Restoration Facility, all of which were reported in March 1999. Each involved deficiencies in electrical distribution equipment supplied by a subcontractor: a damaged circuit breaker and buswork, installation of incorrect overload protection devices in motor control centers (MCCs), a miswired electrical heater, and unterminated ground conductors. These events are significant because they resulted in damaged equipment and unexpected electrical hazards (ORPS Reports SR--WSRC-ERF-1999-0005, SR--WSRC-ERF-1999-0006, SR--WSRC-ERF-1999-0007, and SR--WSRC-ERF-1999-0008)

In 1997, Savannah River contracted with an electrical subcontractor to design, construct, and install an electrical distribution system to support a new groundwater treatment facility. The subcontractor delivered the distribution system and electrical equipment and substantially completed installation in late 1998. The following occurrences are related to deficiencies in the installation.

- On March 11, 1999, personnel performing modifications to an MCC discovered a damaged breaker in a spare location. The breaker exhibited signs that excessive force had been used during its installation. Subsequent investigation revealed that the spare breaker had been previously installed in an active location and that buswork behind the active location was electrically damaged. Facility personnel believe that the damaged breaker had been switched with a spare breaker to conceal the damage, and that this could have happened as long ago as 1997, during off-site pre-installation testing. Corrective actions included the requirement for 100 percent point-to-point verification of wiring with more than 115 V ac of applied voltages and evaluation of improvements to subcontractor turnover processes. (ORPS Report SR--WSRC-ERF-1999-0005)

- On March 12, 1999, an engineer questioned the size of an overload protection device installed in the same MCC as the one with the damaged breaker. Engineers compared motor faceplate data with vendor recommendations for overload protection and determined that more than 50 percent of the installed overload protection devices were oversized for the associated equipment. Facility engineers evaluated other critical, high-cost components for similar deficiencies that may not have been addressed by design reviews, construction inspections, or quality assurance programs. From their evaluations, they developed a verification and inspection plan. (ORPS Report SR--WSRC-ERF-1999-0006)

- On March 16, 1999, construction electricians who were preparing to move a heater discovered an unexpected electrical potential on a circuit supplied from the MCC during a pre-job zero-energy check. The electricians had locked out the heater supply circuit in accordance with the subcontractor's drawings. Construction supervisors stopped all work on the job and examined the facility to determine the cause of the unexpected voltage. They discovered that the heater had been miswired during installation. Corrective actions included re-labeling the MCC to correspond to the current configuration and updating the associated drawings. Engineering personnel will perform a 100 percent verification of all electrical circuits in accordance with the verification and inspection plan developed following the discovery of oversized overload protection devices. (ORPS Reports SR--WSRC-ERF-1999-0007)

- On March 31, 1999, maintenance personnel who were inspecting breakers in an MCC discovered two three-phase cables that did not have their ground wires connected to the MCC grounding bus. They were conducting the inspection in connection with the corrective actions for the miswired heater discovered on March 16, 1999. Unterminated ground conductors create a potentially unsafe condition in the presence of a ground fault. Corrective actions included performing a 100 percent verification of grounding terminations and grounding conductor sizing. (ORPS Reports SR--WSRC-ERF-1999-0008)

OEAF engineers reviewed another recent occurrence involving a deficiency in equipment supplied by a subcontractor. On March 4, 1999, during a pre-job zero-energy check, electrical and instrument personnel at the Savannah River Heavy Water Facility discovered 240 V ac on a circuit they had locked out in preparation for supplying power to a portable building. Power was to be taken from a vendor-supplied power supply consisting of a 480-V transformer center-tapped to supply 240-V single-phase power. They had locked out a breaker that supplied several disconnect switches in accordance with the vendor's drawings. A physical examination of the wiring revealed that some of the disconnect switches were wired to the supply side of the 480-V breaker instead of the load side. In the course of their examination, engineers also discovered that the vendor had wired a 240-V outlet with a hot wire on the neutral terminal. (ORPS Report SR--WSRC-HWFAC-1999-0002)

These occurrences underscore the importance of subcontractor and vendor oversight. In three of these occurrences, wiring errors compromised employee safety. All of the occurrences resulted in added costs for labor and materials.

Recent changes in the DOE mission have led to extensive decommissioning, upgrade of existing facilities, and construction of new facilities. These activities have led to marked increases in the use of subcontracted services, along with proportional increases in the numbers of occurrences among subcontractors involving industrial safety and quality of work. Much of the work of the prime contractor organizations has been redirected to oversight and control of construction and maintenance subcontractors. The following are a few ways in which prime contractors can contribute to the success of subcontracted providers.

- Develop bid specifications that clearly and completely describe what is expected of the subcontractor. An adequately detailed bid specification allows potential subcontractors to submit realistic and achievable proposals and establishes measurable quality standards for both the contractor and the subcontractor.

- Maintain enough direct contact while work is in progress to ensure that subcontractors are complying with contract requirements and are not experiencing serious difficulties with work scope and schedules. Contact should include frequent visits to the work site and regular participation in planning meetings.

Ensure that graded oversight and review are consistent with work significance and hazards.

- Integrate subcontractor personnel into key facility or site administrative and safety training programs. Ensure that subcontractors have been adequately informed of site- and job-specific safety requirements and practices.

- Develop and implement construction and final acceptance tests for deliverables that are consistent with their safety or production significance, complexity, and cost.

KEYWORDS: contractor controls, electrical safety, subcontractor

FUNCTIONAL AREAS: Construction, Management

OEAF FOLLOW-UP ACTIVITY

1. OPERATING EXPERIENCE WEEKLY SUMMARY TO BE AVAILABLE VIA E-MAIL

The Office of Nuclear and Facility Safety will soon be able to send a .pdf version of the OEWS directly to your e-mail. Here are just a few benefits you'll see when you have an electronic copy sent “straight to your desktop.”

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